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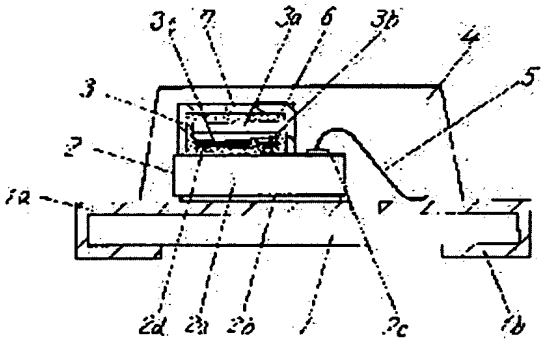
(54) SEMICONDUCTOR LIGHT EMITTING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a semiconductor light emitting device for obtaining a white light emission having a uniform chromaticity in total bearing from a light emitting element, even without accurate formation of a layer or a package of a resin containing a phosphor necessary for wavelength conversion of blue light.

SOLUTION: The surface of the light emitting element 3 including at least a light emitting surface is covered with a wavelength conversion layer 6 for converting the light wavelength of the element 3 with the contained phosphor. Further, the surface of the layer 6 is covered with a light diffusion layer 7 for scattering the light directed from the layer 6 itself toward outward to return the part of the light to the layer 6. Thus, the wavelength converted light is diffused as it is by the layer 7, and radiated. The phosphor is re-stimulated by the partial light returned to the layer 6 and further expedited to obtain white light.



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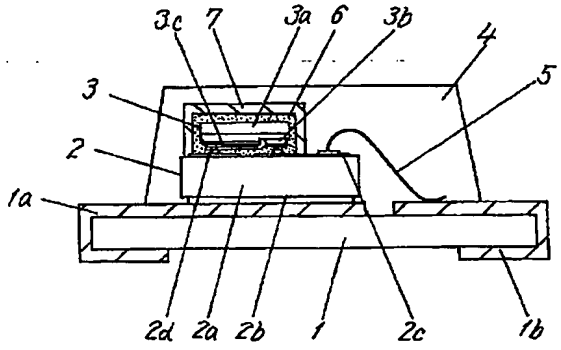
(54)【発明の名称】　半導体発光装置

(57)【要約】
【課題】　青色発光の波長変換に必要な蛍光物質を含む樹脂の層またはパッケージの成形が高精度で得られなくても発光素子から全方位で一様な色度の白色発光が得られる半導体発光装置の提供。
【解決手段】　発光素子３の少なくとも発光面を含む表面を、含有蛍光物質によって発光素子３の発光波長を変換する波長変換層６で被覆し、更にこの波長変換層６の表面を、波長変換層６自身から外に向かう光を散乱させて光の一部を波長変換層６に戻す光拡散層７によって被覆し、波長変換された光をそのまま光拡散層７によって拡散させて放出するとともに波長変換層６に戻された一部の光によって蛍光物質を再励起して更に白色発光化を促す。



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【特許請求の範囲】

【請求項１】　発光素子の少なくとも発光面を含む表面を、含有蛍光物質によって前記発光素子の発光波長を変換する波長変換層で被覆した半導体発光装置であって、前記波長変換層の表面を、当該波長変換層から外に向かう光を散乱させて光の一部を前記波長変換層に戻す光拡散層によって被覆したことを特徴とする半導体発光装置。

【請求項２】　前記光拡散層は、透明樹脂中にSiO_2を混入した成形層であることを特徴とする請求項１記載の半導体発光装置。

【請求項３】　前記光拡散層を透明の光透過性の樹脂によって封止したことを特徴とする請求項１または２記載の半導体発光装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、たとえば青色発光の発光ダイオードによる発光を波長変換して白色発光を得るようにした半導体発光装置に係り、特に発光観測面の方向に関係なく一様な色度で白色発光が可能な半導体発光装置に関する。

【０００２】

【従来の技術】青色発光の発光ダイオード（以下、「ＬＥＤ」と記す）は、近来になって、ＧａＮ，ＧａＡｌＮ，ＩｎＧａＮ及びＩｎＡｌＧａＮ等のＧａＮ系化合物半導体を利用することによって、発光輝度の高い製品が得られるようになった。そして、この青（Ｂ）のＬＥＤと旧来からの赤（Ｒ），緑（Ｇ）発光のＬＥＤとの組合せにより、これらのＬＥＤの３個を１ドットとする高画質のフルカラー画像の形成が可能となった。

【０００３】ＬＥＤの分野では、フルカラー対応には光の三原色のＲ，Ｇ，Ｂ（青）が必要であるから、これらの発光色のＬＥＤのより一層の開発と改良が主である。その一方で、たとえばＲ，Ｇ，Ｂの合成によってしか得られない白色発光を単一のＬＥＤで達成しようとする試みも既になされている。このような試みの一つとして、たとえば特開平７－９９３４５号公報に開示されたものがある。

【０００４】この公報に記載のＬＥＤは、図３の概略図に示すように、発光チップ５０を搭載するリードフレーム５１のマウント部５１ａを含めて樹脂（図示せず）によって封止するいわゆるＬＥＤランプのタイプとしたものである。そして、発光チップ５０の発光波長を変えて異なった発光色とするために、発光チップ５０の周りのマウント部５１ａに蛍光物質を含んだ樹脂５２で封止した構成を持つ。すなわち、旧来のＬＥＤランプでは発光チップを搭載するリードフレームの先端部を含めて被覆するとともにレンズ機能も兼ねるエポキシ樹脂の単層で封止していたものに代えて、発光チップ周りに波長変換用の樹脂層を形成し、その周りをエポキシ樹脂で封止したものである。

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【０００５】このような波長変換用の蛍光物質を含む樹脂５２で発光チップ５０を封止することで、発光チップ５０からの青色発光の波長が蛍光物質によって変えられ、高輝度のＧａＮ系半導体を利用した青色の発光チップを白色発光のデバイスとして使えるようになる。すなわち、ＧａＮ系化合物半導体を利用した青色発光の発光チップ５０の場合では、それ自身の青色発光の成分と、樹脂５２に含まれた蛍光物質によって波長変換された黄緑色の成分との混色によって白色発光が得られる。

【０００６】また、図３のマウント部に発光チップを搭載して砲弾型に樹脂封止するＬＥＤランプに代えて、発光チップをプリント配線基板に表面実装して樹脂封止する半導体発光装置についても、同様に蛍光物質を含む樹脂層によって白色発光を得ることができる。このような半導体発光装置の例としては、たとえば特開平１１－３１８４５号公報に記載のものがある。これは、プリント配線基板の上に実装搭載された発光チップの主光取出し面の上に接着剤の層を塗布してその上面に蛍光体の層を付着させたものである。

【０００７】また、本願出願人は、サブマウント素子の上にｐ側及びｎ側の電極を下向きにして実装した発光素子の周りを蛍光物質を含む樹脂パッケージで封止した白色発光の半導体装置を提案し、特願平１１－３７８８号として出願した。この出願に係る半導体発光装置においても、発光素子からの青色発光を蛍光物質によって波長変換して白色発光を可能としたものである。

【０００８】

【発明が解決しようとする課題】ＬＥＤランプの場合では、発光チップ５０を搭載するマウント部５１ａの内面を光反射面として利用するので、図示の例のようにマウント部５１ａをすり鉢状とすることが有効である。ところが、マウント部５１ａがすり鉢状であると、図３の（ａ）に示すように、発光チップ５０の発光方向と側方の樹脂５２の厚さＡ，Ｂが異なる場合が多い。これらの厚さＡ，Ｂの相違はマウント部５１ａの形状や発光チップ５０の大きさ及び樹脂５２の充填厚さ等によってさまざまに変わる。このため、これらの条件をもし最適化できれば、発光チップ５０周りの全方向で樹脂５２の層厚を均一にすることはできる。しかしながら、樹脂５２はディスペンサによってマウント部５１ａに注入されるので、その厚さを高精度で制御することは非常に難しく、図示のようなＡ，Ｂの厚さの関係だけでなく発光チップ５０周りの樹脂５２の厚さを均一化することは現状では不可能である。

【０００９】発光チップ５０周りの樹脂５２の厚さが異なると、厚さが大きいほど発光チップ５０からの青色発光が黄緑色に変換される割合も高くなる。このため、厚さＡ方向では良好な白色発光が得られても、厚さＢ方向のマウント部５１ａの内周面に近い部分では黄緑色の成

分が白色を上回るようになる。したがって、マウント部５１ａの底面及び内周面を反射面とする発光なので、中央部では白色が占め周縁部では黄色みを帯びた発光となってしまう。

【００１０】一方、先の公報に記載のように発光素子の主光取出し面に対向させて樹脂層を形成するものや、本願出願人による先の出願のフリップチップ型の発光素子周りを蛍光物質含有の樹脂パッケージで封止するものにおいても同様の問題がある。すなわち、樹脂層の塗布や樹脂パッケージによる封止では、その製造技術上の限界から、発光素子の主光取出し面に対してまたはその全周囲に対して一様な厚さとなるように蛍光物質を含む層を形成することは困難である。このため、蛍光物質を含む樹脂層が所定値よりも厚いと発光素子からの光は緑っぽくなり、所定値よりも薄いと青色がかった発光となり、全ての観測面から観たとき色度のばらつきが目立つようになる。

【００１１】このように、青色発光の発光素子周りを蛍光物質を含む樹脂の層やパッケージで被膜しても、これらの層及びパッケージの厚さに応じて波長変換率が変わるので、一様な白色発光は得られない。したがって、観る方角によって色度差が大きく現れてしまい、液晶表示パネル等のバックライト用光源に組み込んだとき色度むらが発生するという問題がある。

【００１２】本発明は、青色発光の波長変換に必要な蛍光物質を含む樹脂の層またはパッケージの成形が高精度で得られなくても発光素子から全方位で一様な色度の白色発光が得られる半導体発光装置を提供することを目的とする。

【００１３】

【課題を解決するための手段】本発明は、発光素子の少なくとも発光面を含む表面を、含有蛍光物質によって前記発光素子の発光波長を変換する波長変換層で被覆した半導体発光装置であって、前記波長変換層の表面を、当該波長変換層から外に向かう光を散乱させて光の一部を前記波長変換層に戻す光拡散層によって被覆したことを特徴とする。

【００１４】このような構成において、光拡散層は透明樹脂中にSiO_2を混入した成形層とすることができ、また光拡散層を透明の光透過性の樹脂によって封止したものとしてもよい。

【００１５】

【発明の実施の形態】請求項１に記載の発明は、発光素子の少なくとも発光面を含む表面を、含有蛍光物質によって前記発光素子の発光波長を変換する波長変換層で被覆した半導体発光装置であって、前記波長変換層の表面を、当該波長変換層から外に向かう光を散乱させて光の一部を前記波長変換層に戻す光拡散層によって被覆したことを特徴とする半導体発光装置であり、波長変換された光を光拡散層で外部に拡散させて放出すると同時に一部を波長変換層に戻すことにより蛍光物質を再励起させて白色化を促すという作用をする。

【００１６】請求項２に記載の発明は、前記光拡散層は、透明樹脂中にSiO_2を混入した成形層であることを特徴とする請求項１に記載の半導体発光装置であり、安価に光拡散層を形成できるという作用を有する。

【００１７】請求項３に記載の発明は、前記光拡散層を透明の光透過性の樹脂によって封止したことを特徴とする請求項１または２記載の半導体発光装置であり、光拡散層を保護して耐用性を向上させるとともに、光透過性の樹脂をレンズ形状とすることにより軸上光度を向上させることができるという作用を有する。

【００１８】以下、本発明の実施の形態について図面に基づき説明する。

【００１９】図１は本発明の一実施の形態による半導体発光装置の概略縦断面図である。

【００２０】図示のように、本発明の半導体発光装置は、実装基板１と、その上に搭載したサブマウント素子２と、その上に搭載した発光素子３と、これらのサブマウント素子２及び発光素子３を含めて封止した透明の樹脂パッケージ４とを主な部材としたものである。そして、発光素子３の周りには、後述するように、白色化のための蛍光物質の樹脂層と光拡散作用による色度均一化のための樹脂層がそれぞれ形成されている。

【００２１】実装基板１は絶縁性であって、従来のフリップチップ型の半導体発光素子と同様にウエハ状態の基板材にスリットを切開したものを用い、このスリットを通して電極１ａ，１ｂをメッキ法によって実装基板１の表裏両面にかけて形成したものである。また、樹脂パッケージ４はサブマウント素子２及び発光素子３の実装及びワイヤボンディングの後にウエハ状態の基板材の表面を樹脂で封止し、最終工程のダイシングによって図示の形状の実装基板１及び樹脂パッケージ４として創成される。

【００２２】サブマウント素子２はｎ型のシリコン基板２ａを用いたもので、このシリコン基板２ａの底面には実装基板１の電極１ａに導通搭載されるｎ電極２ｂを形成している。また、シリコン基板２ａの上面には、このシリコン基板２ａの一部に形成したｐ型半導体領域に接触するｐ側電極２ｃとｎ型半導体領域に接触するｎ側電極２ｄがそれぞれ形成されている。

【００２３】発光素子３は、従来技術の項で述べたＧａＮ系化合物半導体を利用した高輝度の青色発光のＬＥＤである。この発光素子３は、サファイアを素材とした基板３ａの表面に、たとえばＧａＮのｎ型層，ＩｎＧａＮの活性層及びＧａＮのｐ型層を積層したものである。そして、従来周知のように、ｐ型層の一部をエッチングしてｎ型層を露出させ、この露出したｎ型層の表面にｎ側電極３ｂを形成し、ｐ型層の表面にはｐ側電極３ｃを形成し、ｎ側電極３ｂをサブマウント素子２のｐ側電極２

ｃに及びｐ側電極３ｃをサブマウント素子２のｎ側電極２ｄにそれぞれバンプ電極を介して接合している。

【００２４】更に、サブマウント素子２のｐ側電極２ｃと実装基板１の電極１ｂとの間にはワイヤ５がボンディングされている。なお、実装基板１は電子機器等の配線基板に実装されそれぞれの電極１ａ，１ｂをこの配線基板の配線パターンに実装搭載することにより、発光素子３をサブマウント素子２を介して電源回路側に導通させる。また、樹脂パッケージ４は、従来からＬＥＤランプの分野で使用されている光透過性のエポキシ樹脂を素材としたものである。

【００２５】ここで、本発明では、発光素子３の周りを波長変換層６で被膜するとともに、この波長変換層６の表面の全体を光拡散層７で被膜する。波長変換層６は先に説明した特願平１１－３７８８号の出願明細書にも記載しているように、発光素子３の青色発光を白色に変換するための蛍光物質をエポキシ樹脂に混入したものである。この青色発光を白色発光に変換する蛍光物質は、発光素子３の発光色である青色と補色の関係を持つものであればよく、蛍光染料，蛍光顔料，蛍光体などが利用でき、たとえば（Ｙ，Ｇｄ）$_3$（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅ等が好適である。また、光拡散層７は波長変換層６で波長変換された光を散乱及び乱反射させて光の一部を波長変換層６に戻してから蛍光体による白色変換を再励起させるためのものであり、エポキシ樹脂にSiO_2を混入したものである。

【００２６】波長変換層６は発光素子３からの青色発光を白色発光に変換するが、その変換効率は波長変換層６の厚さに依存する。すなわち、前述のように波長変換層６が所定値よりも厚いと緑がかった発光色となり、所定値より薄いと青みが強い発光色となり、厚さが異なる部分の発光観測面からの光は白色光から外れた色調となりやすい。したがって、波長変換層６の厚さは発光素子３の全方位で同じ厚さであって最適な効率で白色光に変換できるように設定することが好ましい。しかしながら、先に説明したように、現状の製造技術の面からは波長変換層６を一様な厚さに成形することは非常に困難である。

【００２７】これに対し、本発明では波長変換層６の表面を光拡散層７によって被覆されているので、波長変換層６を抜けた光は光拡散層７に混入したSiO_2により光拡散または乱反射される。すなわち、波長変換層６から光拡散層７に入射した光は、そのまま放出またはSiO_2による拡散によって外部に照射される成分と、SiO_2により反射されて波長変換層６に戻される成分とに分かれる。このとき、波長変換層６に戻された光は、波長変換層６内の蛍光物質を再励起して更に白色変換が促進され、この変換促進された白色光が光拡散層７に入射して外部に放出される。

【００２８】以上の構成において、発光素子３に通電されるとその発光層からの光が放出される。この場合、透明のサファイアの基板３ａを用いたＧａＮ系化合物半導体の青色発光の発光素子３では、基板３ａの上面を主光取出し面とするものの、基板３ａはこれに積層した半導体薄膜層の底面や側面からも光が放出され、発光素子３の全体の表面がほぼ一様に発光する。そして、発光素子３からの光は蛍光物質を含む波長変換層６を抜ける間に白色に波長変換され、光拡散層７から放出される。

【００２９】ここで、光拡散層７はSiO_2を混入した樹脂層なので、前述のとおり波長変換層６からの光の一部はSiO_2による乱反射を受け、波長変換層６に戻される。したがって、発光素子３から放出された光の一部は再び波長変換層６の蛍光物質によって波長変換され、白色化が促される。このため、波長変換層６の厚さが一様でなくても、光拡散層７からの光の戻りと蛍光物質の再励起による高効率の白色化が達成できる。更に、光拡散層７に混入されたSiO_2によって光が拡散されるので、発光素子３の全方位について一様な白色発光が得られる。

【００３０】このように、波長変換層６の周りに光拡散層７を設けたことにより、白色波長変換の促進と同時に出射光の拡散とが可能となるので、波長変換層６の肉厚を高精度で一様化しなくても、色度むらのない白色発光が可能となる。

【００３１】図２は図３の従来例のようにリードフレームのマウント部に実装して砲弾型のＬＥＤランプとした例の概略縦断面図である。なお、図１の例と同じ構成部材については共通の符号で指示しその詳細な説明は省略する。

【００３２】図２において、二股状のリードフレーム１０の一方のリード１０ａにマウント部１０ｂが形成され、このマウント部１０ｂにサブマウント素子２と発光素子３とからなる複合発光素子が実装搭載され、エポキシ樹脂による樹脂パッケージ１１によって封止されている。サブマウント素子２と発光素子３との導通構造は図１の例と全く同様であり、サブマウント素子２の底面のｎ電極２ｂをマウント部１０ｂに導通搭載し、サブマウント素子２の上面のｐ側電極２ｃと他方のリード１０ｃとの間をワイヤ１２によってボンディングしている。

【００３３】マウント部１０ｂの中には、先の例と同様に蛍光物質を混入したエポキシ樹脂がディスペンサによって注入され、これによりサブマウント素子２及び発光素子３の全体を被覆する波長変換層１３が形成されている。そして、この波長変換層１３の表面には、ディスペンサまたはコーティング用具によりSiO_2を混入したエポキシ樹脂を素材とする光拡散層１４が形成されている。

【００３４】この例においても、発光素子３からの光は波長変換層１３を抜けるときに白色光に波長変換され、一部は光拡散層１４をそのまま抜けて放射され、残りは

光拡散層１４に混入したＳｉO_2によって乱反射されて波長変換層１３に戻る挙動をする。したがって、図１の例と同様に、波長変換層１３の蛍光物質の再励起による白色化の促進と光拡散層１４のＳｉO_2による光拡散の相乗効果によって、色度むらのない一様な発光色を全方位に放出することができる。特に、波長変換層１３をディスペンサによる樹脂注入により行い図示のように凸面の山状に波長変換層１３が形成され、発光素子３の上面の光取出し面との間が平行でなく肉厚差が大きくても、光拡散層１４の機能によって良好な白色光が得られる。

【００３５】なお、以上の実施の形態では、エポキシ樹脂に蛍光物質を混入したものを波長変換層６，１３として発光素子３の周りに形成したが、これに代えて蛍光体を発光素子３の表面に付着させたものとしてもよい。すなわち、先に例示した（Ｙ，Ｇｄ）$_3$（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅ等の蛍光染料，蛍光顔料，蛍光体などをそのまま発光素子３の発光面に塗布したりして蛍光体層を形成すればよく、このような蛍光体層によっても発光素子３からの青色発光を白色光に変換することができる。

【００３６】

【発明の効果】本発明では、発光素子の光を波長変換する波長変換層を一様な厚さに形成しなくても、その表面に設けた光拡散層によって、波長変換された光を光拡散層で外部に拡散させて放出すると同時に一部を波長変換層に戻すことにより蛍光物質を再励起させて白色化を促すことができる。したがって、拡散と白色化の促進とにより発光素子の全方位に一様な色度及び色調の白色発光を得ることができ、各種の用途の光源として有効に利用できる。

【００３７】また、光拡散層に混入するＳｉO_2等の拡散材の量を変更することで色度のコントロールもできるので、発色の色度を微妙に調整でき、要求される発光色にマッチした製品が作成できる。

【図面の簡単な説明】

＊【図１】本発明の一実施の形態による半導体発光装置の概略縦断面図

【図２】リードフレームのマウント部に搭載して樹脂封止したＬＥＤランプ型とした例の半導体発光装置の概略縦断面図

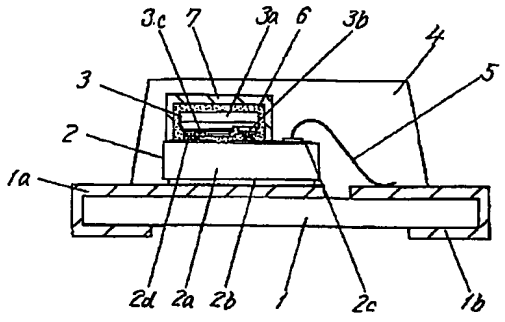
【図３】青色発光の発光素子を樹脂に蛍光物質を混入した波長変換層によって封止した従来例であって、（ａ）はその概略縦断面図

（ｂ）は概略平面図

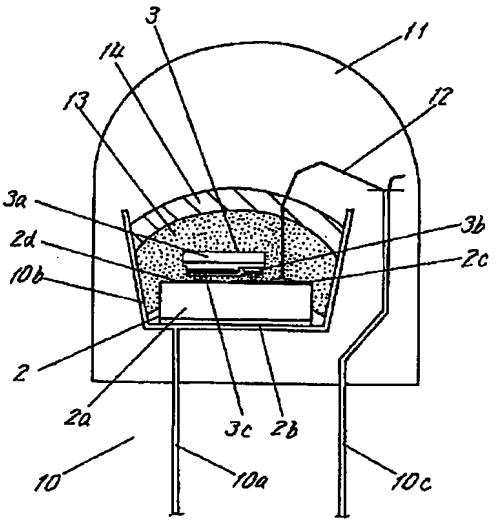
【符号の説明】

１　実装基板
１ａ，１ｂ　電極
２　サブマウント素子
２ａ　シリコン基板
２ｂ　ｎ電極
２ｃ　ｐ側電極
２ｄ　ｎ側電極
３　発光素子
３ａ　基板
３ｂ　ｎ側電極
３ｃ　ｐ側電極
４　樹脂パッケージ
５　ワイヤ
６　波長変換層
７　光拡散層
１０　リードフレーム
１０ａ　リード
１０ｂ　マウント部
１０ｃ　リード
１１　樹脂パッケージ
１２　ワイヤ
１３　波長変換層
１４　光拡散層

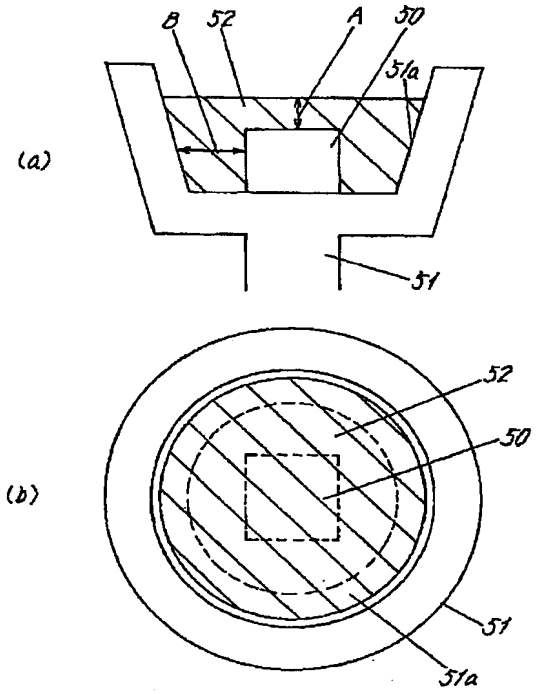
【図１】



【図２】


3
11
14
13
12
3a
3b
2d
2c
10b
2
2a
3c
2b
10
10a
10c

【図３】


(a)
B
52
A
50
51a
51
(b)
52
50
51
51a

PATENT ABSTRACTS OF JAPAN

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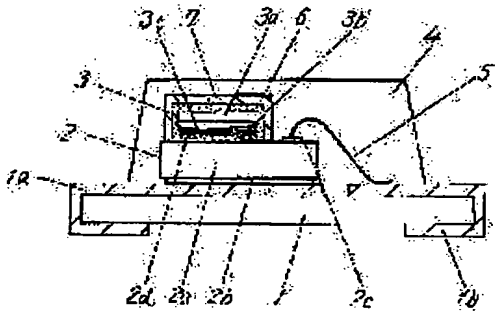
(72)Inventor : IKEDA TADAAKI

(54) SEMICONDUCTOR LIGHT EMITTING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a semiconductor light emitting device for obtaining a white light emission having a uniform chromaticity in total bearing from a light emitting element, even without accurate formation of a layer or a package of a resin containing a phosphor necessary for wavelength conversion of blue light.
SOLUTION: The surface of the light emitting element 3 including at least a light emitting surface is covered with a wavelength conversion layer 6 for converting the light wavelength of the element 3 with the contained phosphor. Further, the surface of the layer 6 is covered with a light diffusion layer 7 for scattering the light directed from the layer 6 itself toward outward to return the part of the light to the layer 6. Thus, the wavelength converted light is diffused as it is by the layer 7, and radiated. The phosphor is re-stimulated by the partial light returned to the layer 6 and further expedited to obtain white light.



* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]It is the semiconductor emission device which covered the surface of a light emitting device which includes a light-emitting surface at least with a wavelength conversion layer which changes a luminous wavelength of said light emitting device with a content fluorescent substance, A semiconductor emission device covering with a light diffusion layer which scatters light which goes the surface of said wavelength conversion layer outside from the wavelength conversion layer concerned, and returns a part of light to said wavelength conversion layer.
[Claim 2]The semiconductor emission device according to claim 1, wherein said light diffusion layer is a molding layer which mixed SiO_2 into transparent resin.
[Claim 3]The semiconductor emission device according to claim 1 or 2 closing said light diffusion layer with resin of a transparent light transmittance state.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the semiconductor emission device which carries out wavelength changing of the luminescence by the light emitting diode of blue light, for example, and obtained white light, especially relates to the semiconductor emission device in which white light is possible with a uniform chromaticity regardless of the direction of a luminescence observation surface.
[0002]
[Description of the Prior Art]The light emitting diode (it is hereafter described as "LED") of blue light becomes these days, and a product with high light emitting luminance came to be obtained by using GaN system compound semiconductors, such as GaN, GaAlN and InGaN, and InAlGaN. And formation of the high-definition full color image which makes three of such LED 1 dot was attained with the combination of this LED of blue (B), and LED of the red (R) from the former, and green (G) luminescence.
[0003]Since trichromatic R of light, G, and B (blue) are required for full color correspondence in the field of LED, the much more development and improvement of LED of these luminescent color are main. It is one of these and the trial which is going to attain the white light obtained only, for example by composition of R, G, and B by single LED is also already made. As one of such the trials, there are some which were indicated by JP,7-99345,A, for example.
[0004]LED given in this gazette is taken as the so-called type of the LED lamp closed with resin (not shown) including the mount part 51a of the leadframe 51 which carries the light emitting chip 50, as shown in the schematic diagram of drawing 3. And in order to make the luminous wavelength of the light emitting chip 50 into the luminescent color which changed and differed, it has the composition closed by the resin 52 which contained the fluorescent substance in the surrounding mount part 51a of the light emitting chip 50. Namely, it replaces with what was being closed by the monolayer of the epoxy resin which serves also as a lens function while covering with the conventional LED lamp including the tip part of a leadframe in which a light emitting chip is carried, The resin layer for wavelength changing is formed in the circumference of a light emitting chip, and the surroundings of it are closed with an epoxy resin.
[0005]By closing the light emitting chip 50 by the resin 52 containing such a fluorescent substance for wavelength changing, the wavelength of the blue light from the light emitting chip 50 is changed with a fluorescent substance, and the blue light emitting chip using a high-intensity GaN system semiconductor can be used now as a device of white light. That is, in the case of the light emitting chip 50 of the blue light using a GaN system compound semiconductor, white light is obtained with the mixed colors of the ingredient of the blue light of itself, and the yellow-green ingredient by which wavelength changing was carried out with the fluorescent substance contained in the resin 52.
[0006]It can replace with the LED lamp which carries a light emitting chip in the mount part of drawing 3, and carries out a resin seal to an artillery shell type, and white light can be obtained by the resin layer which contains a fluorescent substance similarly also about the semiconductor emission device which carries out the surface mount of the light emitting chip to a printed-

circuit board, and carries out a resin seal. As an example of such a semiconductor emission device, JP,11-31845,A has a thing of a statement, for example. This applies the layer of adhesives on the main light drawing side of the light emitting chip by which mounting loading was carried out on the printed-circuit board, and makes the layer of a fluorescent substance adhere to the upper surface.

[0007]The applicant for this patent proposed the semiconductor device of the white light which closed the surroundings of the light emitting device which placed the electrode by the side of p and n upside down, and mounted it on the submount element with the resin package containing a fluorescent substance, and applied as Japanese Patent Application No. No. 3788 [11 to]. Also in the semiconductor emission device concerning this application, wavelength changing of the blue light from a light emitting device is carried out with a fluorescent substance, and white light is made possible.

[0008]

[Problem(s) to be Solved by the Invention]Since the inner surface of the mount part 51a in which the light emitting chip 50 is carried is used as a light reflection surface in the case of a LED lamp, it is effective to make the mount part 51a into the shape of an earthenware mortar like the example of a graphic display. However, as it indicates (a) of drawing 3 that the mount part 51a is an earthenware mortar-like, thickness [of the light-emitting direction of the light emitting chip 50 and the resin 52 of the side] A differs from B in many cases. The difference of such thickness A and B changes variously with the shape of the mount part 51a, the size of the light emitting chip 50, the restoration thickness of the resin 52, etc. For this reason, if these conditions can be optimized, thickness of the resin 52 can be made uniform in all the directions of the circumference of the light emitting chip 50. However, since the resin 52 is poured into the mount part 51a by a dispenser, it is dramatically difficult to control the thickness by high degree of accuracy, and, under the present circumstances, it is impossible to equalize the thickness of the resin 52 of not only the relation of the thickness of A like a graphic display and B but the circumference of the light emitting chip 50.

[0009]If the thickness of the resin 52 of the circumference of the light emitting chip 50 differs, the rate that the blue light from the light emitting chip 50 is changed into yellowish green will also become high, so that thickness is large. For this reason, in the direction of thickness A, even if good white light is obtained, in the portion near the inner skin of the mount part 51a of the direction of thickness B, a yellow-green ingredient comes to exceed white. Therefore, since it is luminescence which makes a reflector the bottom and inner skin of the mount part 51a, in the center section, it will be luminescence which white occupied and is tinged with yellowness in an edge part.

[0010]There is same problem also in what closes the circumference of the flip chip type light emitting device of application of what, on the other hand, makes the main light drawing side of a light emitting device counter a previous gazette like a statement, and forms a resin layer, and the point by an applicant for this patent with the resin package of fluorescent substance content. That is, it is difficult to form the layer which contains a fluorescent substance from the limit on the production technology in closure by spreading and the resin package of a resin layer so that it may become uniform thickness to the perimeter enclosure as opposed to the main light drawing side of a light emitting device. For this reason, when it sees from all the observation surfaces, dispersion in a chromaticity comes to be conspicuous [when the resin layer containing a fluorescent substance is thicker than a predetermined value, the light from a light emitting device comes appropriate for green, it becomes luminescence which is bluish when thinner than the predetermined value and].

[0011]Thus, even if it carries out the tunic of the circumference of the light emitting device of blue light with the layer and package of resin containing a fluorescent substance, since the rate of wavelength changing changes according to these layers and the thickness of a package, uniform white light is not obtained. Therefore, when chromaticity difference appears greatly and includes in light sources for back lights, such as a liquid crystal display panel, by the direction to see, there is a problem that chromaticity unevenness occurs.

[0012]An object of this invention is to provide the semiconductor emission device with which the

white light of a uniform chromaticity is obtained from a light emitting device in an omnidirection even if the layer of resin or shaping of a package containing a fluorescent substance required for the wavelength changing of blue light is not obtained with high degree of accuracy.
[0013]
[Means for Solving the Problem]This invention is the semiconductor emission device which covered the surface of a light emitting device which includes a light-emitting surface at least with a wavelength conversion layer which changes a luminous wavelength of said light emitting device with a content fluorescent substance, It covered with a light diffusion layer which scatters light which goes the surface of said wavelength conversion layer outside from the wavelength conversion layer concerned, and returns a part of light to said wavelength conversion layer.
[0014]In such composition, a light diffusion layer is good also as what could consider it as a molding layer which mixed SiO_2 into transparent resin, and closed a light diffusion layer with resin of a transparent light transmittance state.
[0015]
[Embodiment of the Invention]The invention according to claim 1 the surface of a light emitting device which includes a light-emitting surface at least, It is the semiconductor emission device covered with the wavelength conversion layer which changes the luminous wavelength of said light emitting device with a content fluorescent substance, It is a semiconductor emission device covering with the light diffusion layer which scatters the light which goes the surface of said wavelength conversion layer outside from the wavelength conversion layer concerned, and returns a part of light to said wavelength conversion layer, By returning a part to a wavelength conversion layer, a fluorescent substance is re-excited and the operation of urging whitening is carried out at the same time it diffuses outside the light by which wavelength changing was carried out and emits it by a light diffusion layer.
[0016]The invention according to claim 2 has the operation that said light diffusion layer is the semiconductor emission device according to claim 1 being the molding layer which mixed SiO_2, and can form a light diffusion layer cheaply into transparent resin.
[0017]While being the semiconductor emission device according to claim 1 or 2, wherein the invention according to claim 3 closes said light diffusion layer with resin of a transparent light transmittance state, protecting a light diffusion layer and raising durability, It has the operation that the degree of axial Uemitsu can be raised, by making resin of a light transmittance state into lens shape.
[0018]Hereafter, an embodiment of the invention is described based on a drawing.
[0019]Drawing 1 is outline drawing of longitudinal section of the semiconductor emission device by the 1 embodiment of this invention.
[0020]Like a graphic display, the semiconductor emission device of this invention uses as the main members the transparent resin package 4 closed including the mounting board 1, the submount element 2 carried on it, the light emitting devices 3 carried on it, and these submount elements 2 and light emitting devices 3. And the resin layer of the fluorescent substance for whitening and the resin layer for chromaticity equalization by an optical diffusion are formed in the surroundings of the light emitting device 3, respectively so that it may mention later.
[0021]The mounting board 1 is insulation, and it forms with plating through this slit using what cut the slit open to the substrate material of the wafer state like the conventional flip chip type semiconductor light emitting element, applying the electrodes 1a and 1b to rear surface both sides of the mounting board 1. The resin package 4 closes the surface of the substrate material of a wafer state by resin mounting of the submount element 2 and the light emitting device 3, and after wirebonding, and is created by dicing of a final process as the mounting board 1 and the resin package 4 of shape of a graphic display.
[0022]The submount element 2 is a thing using the n type silicon substrate 2a, and n electrode 2b by which flow loading is carried out is formed in the electrode 1a of the mounting board 1 at the bottom of this silicon substrate 2a. The n lateral electrode 2d in contact with the p lateral electrode 2c in contact with the p type semiconductor region formed in a part of this silicon

substrate 2a and a n type semiconductor region is formed in the upper surface of the silicon substrate 2a, respectively.

[0023]The light emitting device 3 is LED using the GaN system compound semiconductor described by the paragraph of conventional technology of high-intensity blue light. This light emitting device 3 laminates the n type layer of GaN, the active layer of InGaN, and the p type layer of GaN on the surface of the substrate 3a made from sapphire, for example. And conventionally, as everyone knows, etch a part of p type layer, and a n type layer is exposed, The n lateral electrode 3b was formed in the surface of this exposed n type layer, the p lateral electrode 3c was formed on the surface of the p type layer, and the p lateral electrode 2c of the submount element 2 and the p lateral electrode 3c are joined to the n lateral electrode 2d of the submount element 2 respectively via a bump electrode for the n lateral electrode 3b.

[0024]Bonding of the wire 5 is carried out between the p lateral electrode 2c of the submount element 2, and the electrode 1b of the mounting board 1. The mounting board 1 makes it flow through the light emitting device 3 in the power supply circuit side via the submount element 2 by being mounted in wiring boards, such as electronic equipment, and carrying out mounting loading of each electrode 1a and 1b at the circuit pattern of this wiring board. The resin package 4 is made from the epoxy resin of the light transmittance state currently used in the field of the LED lamp from the former.

[0025]Here, in this invention, while carrying out the tunic of the surroundings of the light emitting device 3 by the wavelength conversion layer 6, the tunic of the whole surface of this wavelength conversion layer 6 is carried out by the light diffusion layer 7. The wavelength conversion layer 6 mixes the fluorescent substance for changing the blue light of the light emitting device 3 white in an epoxy resin, as written also in the application specification of Japanese Patent Application No. No. 3788 [11 to] explained previously. The fluorescent substance which changes this blue light into white light has a relation of the blue and the complementary color which are the luminescent color of the light emitting device 3, and fluorescent dye, a fluorescent pigment, a fluorescent substance, etc. are just used for it, for example (Y, Gd) $_3$(aluminum, Ga) $_5O_{12}$:Ce etc. are preferred for it. The light diffusion layer 7 is for re-exciting dispersion and the white conversion by a fluorescent substance after carrying out scattered reflection and returning a part of light to the wavelength conversion layer 6 for the light by which wavelength changing was carried out by the wavelength conversion layer 6, and mixes SiO_2 in an epoxy resin.

[0026]Although the wavelength conversion layer 6 changes the blue light from the light emitting device 3 into white light, it depends for the conversion efficiency on the thickness of the wavelength conversion layer 6. That is, it becomes the luminescent color which is greenish when the wavelength conversion layer 6 was thicker than the predetermined value as mentioned above, if thinner than a predetermined value, blueness will become luminescent color [strong], and the light from the luminescence observation surface of a portion where thickness differs serves as a color tone from which it separated from white light easily. Therefore, the thickness of the wavelength conversion layer 6 is the thickness same in the omnidirection of the light emitting device 3, and it is preferred to set up so that it can change into white light at the optimal efficiency. However, as explained previously, it is dramatically difficult to fabricate the wavelength conversion layer 6 in uniform thickness from the field of the present production technology.

[0027]On the other hand, since the light diffusion layer 7 covers the surface of the wavelength conversion layer 6 with this invention, it is light-spread or the light which escaped from the wavelength conversion layer 6 is reflected irregularly by SiO_2 mixed in the light diffusion layer 7. That is, the light which entered into the light diffusion layer 7 from the wavelength conversion layer 6 is divided into the ingredient irradiated outside by discharge or diffusion by SiO_2 as it is, and the ingredient which is reflected by SiO_2 and returned to the wavelength conversion layer 6. At this time, the fluorescent substance in the wavelength conversion layer 6 is re-excited, white conversion is promoted further, this white light by which conversion promotion was carried out enters into the light diffusion layer 7, and the light returned to the wavelength conversion layer 6

is emitted outside.

[0028]In the above composition, if it energizes to the light emitting device 3, the light from the luminous layer will be emitted. In this case, in the light emitting device 3 of the blue light of the GaN system compound semiconductor using the substrate 3a of transparent sapphire, although the upper surface of the substrate 3a is made into a main light drawing side, light is emitted also from the bottom and the side of the semiconductor thin film layer which laminated the substrate 3a to this, and the surface of the whole light emitting device 3 emits light to about 1 appearance. And while escaping from the wavelength conversion layer 6 containing a fluorescent substance, wavelength changing of the light from the light emitting device 3 is carried out white, and it is emitted from the light diffusion layer 7.

[0029]Here, since the light diffusion layer 7 is a resin layer which mixed SiO_2, as above-mentioned, a part of light from the wavelength conversion layer 6 receives the scattered reflection by SiO_2, and it is returned to the wavelength conversion layer 6. Therefore, again, with the fluorescent substance of the wavelength conversion layer 6, wavelength changing of a part of light emitted from the light emitting device 3 is carried out, and it is urged to whitening. For this reason, even if the thickness of the wavelength conversion layer 6 is not uniform, efficient whitening by re-excitation of the return of the light from the light diffusion layer 7 and a fluorescent substance can be attained. Since light diffuses by SiO_2 mixed in the light diffusion layer 7, white light uniform about the omnidirection of the light emitting device 3 is obtained.

[0030]Thus, since diffusion of emitted light is attained simultaneously with promotion of white wavelength changing by having formed the light diffusion layer 7 in the surroundings of the wavelength conversion layer 6, even if it does not carry out entropy of the thickness of the wavelength conversion layer 6 with high degree of accuracy, white light without chromaticity unevenness becomes possible.

[0031]Drawing 2 is outline drawing of longitudinal section of the example which was mounted in the mount part of a leadframe like the conventional example of drawing 3, and was used as the artillery shell type LED lamp. It points with numerals common about the same members forming as the example of drawing 1, and the detailed explanation is omitted.

[0032]in drawing 2 -- two forks -- the mount part 10b is formed in one lead 10a of the leadframe 10 of **, mounting loading of the compound light emitting element which becomes this mount part 10b from the submount element 2 and the light emitting device 3 is carried out, and it is closed with the resin package 11 by an epoxy resin. The conduction mechanism of the submount element 2 and the light emitting device 3 is completely the same as that of the example of drawing 1, carries out flow loading of the n electrode 2b of the bottom of the submount element 2 at the mount part 10b, and is carrying out bonding of between the p lateral electrode 2c of the upper surface of the submount element 2, and the leads 10c of another side with the wire 12.

[0033]In the mount part 10b, the epoxy resin which mixed the fluorescent substance like the previous example is poured in by a dispenser, and the wavelength conversion layer 13 which covers the submount element 2 and the whole light emitting device 3 by this is formed. And the light diffusion layer 14 made from the epoxy resin which mixed SiO_2 with a dispenser or coating tools is formed in the surface of this wavelength conversion layer 13.

[0034]Also in this example, when escaping from the wavelength conversion layer 13, wavelength changing of the light from the light emitting device 3 is carried out to white light, a part escapes from the light diffusion layer 14 as it is, and is emitted, and the remainder carries out the action in which scattered reflection is carried out by SiO_2 mixed in the light diffusion layer 14 and which returns to the wavelength conversion layer 13 by it. Therefore, the uniform luminescent color without chromaticity unevenness can be emitted to an omnidirection like the example of drawing 1 according to promotion of whitening by re-excitation of the fluorescent substance of the wavelength conversion layer 13, and the synergistic effect of the optical diffusion by SiO_2 of the light diffusion layer 14. In particular, the resin injection by a dispenser performs the wavelength conversion layer 13, the wavelength conversion layer 13 is formed in convex mountain shape like

a graphic display, and even if between the optical drawing sides of the upper surface of the light emitting device 3 is not parallel and thickness difference is large, good white light is acquired with the function of the light diffusion layer 14.

[0035]Although what mixed the fluorescent substance in the epoxy resin was formed in the surroundings of the light emitting device 3 as the wavelength conversion layers 6 and 13 in an above embodiment, it is good also as a thing which replaced with this and made the fluorescent substance adhere to the surface of the light emitting device 3. Namely, what is necessary is to apply to the light-emitting surface of the light emitting device 3 fluorescent dye, such as $_3$(Y, Gd) (aluminum, Ga) $_5O_{12}$:Ce illustrated previously, a fluorescent pigment, a fluorescent substance, etc. as it is, and just to form a fluorescent substance layer. The blue light from the light emitting device 3 is convertible for white light also by such a fluorescent substance layer.

[0036]

[Effect of the Invention]Even if it does not form in uniform thickness the wavelength conversion layer which carries out wavelength changing of the light of a light emitting device in this invention, While diffusing outside the light by which wavelength changing was carried out and emitting it by a light diffusion layer by the light diffusion layer provided in the surface, by returning a part to a wavelength conversion layer, a fluorescent substance can be re-excited and whitening can be urged. Therefore, the white light of a uniform chromaticity and a color tone can be obtained to the omnidirection of a light emitting device by diffusion and promotion of whitening, and it can use effectively as a light source of various kinds of uses.

[0037]Since control of a chromaticity can also be performed by changing the quantity of dispersing agents, such as SiO_2 mixed in a light diffusion layer, the chromaticity of coloring can be adjusted delicately and the product which matched the luminescent color demanded can be created.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]Outline drawing of longitudinal section of the semiconductor emission device by the 1 embodiment of this invention
[Drawing 2]Outline drawing of longitudinal section of the semiconductor emission device of the example used as the LED lamp type which carried and carried out the resin seal to the mount part of the leadframe
[Drawing 3]It is the conventional example which closed the light emitting device of blue light by the wavelength conversion layer which mixed the fluorescent substance in resin, and (a) is the outline drawing of longitudinal section.
(b) is an outline top view.
[Description of Notations]
1 Mounting board
1a and 1b Electrode
2 Submount element
2a Silicon substrate
2b n electrode
2c p lateral electrode
2d n lateral electrode
3 Light emitting device
3a Substrate
3b n lateral electrode
3c p lateral electrode
4 Resin package
5 Wire
6 Wavelength conversion layer
7 Light diffusion layer
10 Leadframe
10a Lead
10b Mount part
10c Lead
11 Resin package
12 Wire
13 Wavelength conversion layer
14 Light diffusion layer

[Translation done.]